The introduction of aquatic species into Samoan villages

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Introduction

A decline of catches of fish and shellfish in the lagoons and inshore reefs of Samoa over the past years, has been reported by Horsman & Mulipola, (1995). Fasili & King (1995) have inferred that this is due to a combination of overexploitation, the use of destructive fishing methods (including the use of dynamite and bleach) and the occurrence of several sequential natural environmental disturbances, (including cyclones Ofa, 1990, and Valelia, 1991). Accordingly, a three year AusAID funded, Fisheries Extension and Training Project, was endorsed by the Government of Samoa in 1995 to assist in alleviating the situation. The primary goal of the project has been to achieve ***"an improved standard of living for Samoan fishers and their families, and, to increase supplies of local seafood".***

The process adopted to achieve this goal has involved community-focussed extension plans to manage local resources. By necessity, alternative sources of seafood to those gleaned from over-exploited near-shore reefs and lagoons, have needed to be identified. The aquaculture of giant clams and tilapia, has provided the possibility for two alternative food sources for Samoans.

Since the project began, a total of 46 marine reserves have been declared in Samoa. Reserves are located between the shore and the main barrier reef, and are variable in total area. They are sited around the islands of Upolu, Savaii and Manono and each is managed by an elected Village Management Advisory Committee, comprising of men and women from the village. The establishment of a series of sometimes-interconnected marine reserves, where all fishing is banned, is expected to facilitate the growth of marine organisms, including corals and algae, and to increase the breeding numbers of fish and shellfish in these areas. In many instances, village management plans have also included the establishment of clam farming and the introduction of tilapia to local water sources. This report summarises the progress of the aquaculture component of the three year project (February 1995 - February 1998), and it's extension phase (March-August 1998).

Aquaculture as a source of seafood

Introduction of tilapia

The present culture of fish is based on a fast-growing species of tilapia, *Tilapia niloticus,* imported from Fiji for quarantine, study and distribution. Palatability studies conducted by the Fisheries Division in 1995 and 1996, have shown tilapia to be acceptable to Samoan taste preference. Project support has included pond construction and the provision of funds for attendance at aquaculture workshops.

During the first phase of the project, tilapia farming was commenced in 12 locations on Upolu and Savaii. Table 1 provides a summary of the current status of these areas. Monitoring of pond status, restocking and harvesting, by the Fisheries Division research team in Upolu, has been carried out

relatively irregularly and mostly through demand by only a few individuals, many of whom are women. Monitoring in Savaii is also intermittent, mainly due to staff shortages.

Observation of village aquaculture practice by Fisheries Extension and Research staff indicates that the concept of a regular feeding regime for the fish is poorly understood. Most remaining tilapia survive because of existing nutrients within the pond. The need for ongoing maintenance workshops, in existing sites, where feeding is emphasised is a clear priority.

Table 1: Introduction and summary information for the aquaculture of the freshwater fish, *Tilapia niloticus,* by commencement date, numbers and location for the period February, 1995 to February 1998 inclusive.

Date	Numbers	Location	Comments
16/6/96 30/9/97	1000 13	Sato'alepai (Savaii)	Good supplies of fish, breeding and harvested regularly. Used by village and occasionally sold in strings
8/11/96 24/1/96 28/6/97	1575 500 830	Chanel pond 1	Harvested 18/6/97. Fish from Pond 2. Harvested XXX Harvested XXX Pond currently dry due to lack of rain
8/11/96	800	Letoga	Harvested 24/7//97
24/1/97	500	Chanel pond 2	Pond unsatisfactory. Not in use
19/2/97	1000	Lotofaga	Not harvested since 1997 & no feeding regime.Requires followup.
28/5/97	500	Pua pu'a* (Savaii)	One pond has dried up. The other has no fish. Requires followup.
28/6/97	500	Fagamalo (Savaii)	Good supplies of fish, breeding and harvested regularly. Used by village and occasionally sold in strings
11/8/97	100	Tafua (Savaii)	Fish viable. No feeding regime. Requested assistance with plans for second pond 29/6/98.
21/8/97	60	Auala (Savaii)	No fish left in cage.
16/9/97	2000	Mulivai	Fish have escaped into river. No feeding regime
24/9/97	1500	Poutasi	A few large fish still viable. Requested assistance to restock pond in June 98. Supported July 98.
29/9/97	900	Asaga (Savaii)	No fish left in pond. Requires followup.

From early July 1998, a more regular monitoring program has been instigated which specifically targets ponds with caged tilapia. A number of variables being tracked, including the physical parameters and status of the pond, feeding regime followed, type of food supplied, reproductive and health status of fish, growth (weight and length) and village marketing practise and distribution of yield. Table 2, summarises the introduction of tilapia which occured during the extension phase of the project. Tilapia were introduced into an additional six villages, totalling 20 locations, country-wide.

Table 2: Introduction and restocking of the freshwater fish, *Tilapia niloticus* for the period March to August 1998 inclusive

Date 98	Species	Numbers	Location	Comments
09 April	Tilapia	1000	Faleapuna	Fingerlings (10cm) 26 died in transit
16 April	Tilapia	1000	Sapapalii	Fingerlings (10cm) 47 died in transit
12 May	Tilapia	1000	Saluafata	Fingerlings (6cm) 10 died in transit
05 June	Tilapia	20	Faleapuna*	Fingerlings (13cm) cage culture
05 June	Tilapia	20	Saluafata*	Fingerlings (10cm) cage culture
20 July	Tilapia	280	Fasito'otai	Fingerlings (10cm) too shallow for cage
August	Tilapia	250	Gagaifo	Fingerlings (10cm) waiting for pond to be cleared and deepened: too shallow for cage
RESTOCKING				
10 July	Tilapia	500	Malaela	Fingerlings (7.5cm) in constructed pond
27-29? July	Tilapia	250	Poutasi*	Fingerlings (10cm) 1 cage installed

Information and support for the introduction of tilapia aquaculture into these villages, was provided by a number of community introduction and maintenance workshops. They were conducted by Fisheries Research and Extension staff with the support of the AusAID project. The workshop programme is summarised in Table 3.

Table 3: Introduction and maintenance workshop programme for the extension phase: *Tilapia niloticus*

09 April 98	Tilapia introduction workshop for community	Faleapuna
16 April 98	Tilapia introduction workshop for community	Sapapalii
12 May 98	Tilapia introduction workshop for community	Saluafata
10 June 98	Tilapia maintenance workshop	Poutasi
29 June 98	Tilapia maintenance workshops	Faala; Tafua; Sapapali'i (Savaii).
10 July 98	Tilapia introduction and maintenance workshop	Malaela
13 July 98	Tilapia maintenance workshops	Saleaaumua
20 July 98	Tilapia introduction and maintenance workshop	Faasito'o tai

In addition to the aquaculture of tilapia, the aquaculture of marine species, (*Mugil sp*) commenced in **xxx CHECK**. This feasibility study at Satapuala continues to be monitored by the Division. A summary of the restocking program is presented in Table 4. Plans to extend the aquaculture of marine species in other suitable areas are currently under consideration by the Fisheries Division

Table 4: Introduction and restocking of the marine fish, *Mugil* sp.

TBA	Mullet		Satapuala	Fingerlings (mean size= cm) in constructed pond
TBA	Mullet		Satapuala	Fingerlings (cm)
TBA	Mullet		Satapuala	Fingerlings (cm)
17 June	Mullet	68	Satapuala	Fingerlings (cm)

Introduction of giant clams

During Phase 1 of the project, giant clams *Tridacna derasa*, were restocked in 37 Village Fish Reserves on Upolu (21 villages), Manono (5 villages) and Savaii (11 villages), to form undisturbed breeding populations. The number of clams supplied to different villages has varied, dependant on clam availability at the Fisheries Division. Most clams were housed on *small stone* substrates in plastic trays. Trays were initially encased in plastic mesh for protection of small clams from larger predators. Each mesh cage contained two trays. From the total number of clams supplied to a village, two trays of clams are selected for tagging, to enable monitoring of growth rates. In some instances, (Fusi Safata and Gagaifo), a small number of clams have been placed directly on the sea floor, thus facilitating the comparison of growth of clams caged:uncaged.

The Research Unit of the Fisheries Division currently continues to monitor growth rates of tagged clams. Since May 1998, monitoring has been more systematic with the Research team visiting each village on a once-a-month basis. Baseline data of mean length was not recorded at the time of introduction. However, in most instances, measurement commenced about 2 months after this time. Mortality rates of total stock per village have also been assessed. Table 5 gives current stock levels and tagged growth rates since introduction. In general, growth rates average at about 4.4mm per month. This rate is similar to that reported for other Pacific localities. (Munro, 1993)

Mortality rates are relatively high, although not unusual compared to other studies (Pearson and Munro, 1991; Munro, 1993). However there is evidence that some clams have been lost because of

rough weather and theft, as well as poor management practises. Some villages have failed to adhere to a consistent cage cleaning regime with regular removal of predatory snails.

Table 5: Date of introduction, growth rates and current stock levels to July1998: *Tridacna derasa*

Date of intro	N	Location	Initial Mean Size tag 1	Mean growth rate (mm)	Initial Mean Size tag 2	Mean growth rate (mm)	Current stock July 98	Last measure date for tags	Comments
28/6/96	1613	Moamoa					183		
28/6/96	2150	Tauo'o	98.6*	4.3*			459	5/12/97	Tag ID's and numbers of clams per tray have changed
8/8/97	1200	Fusi Safata	96.9	3.1	97.6	3.32	458	16/7/98	1000 clams on 17/8/98 (FAO) 617
8/8/97	1200	Tafitoala	84.7	4.73	103.7	2.92	600	17/7/98	smaller clam grow faster
11/8/97	1200	Salua-uta	82.1	3.56	112.7	3.51	834	12/6/98	
14/8/97	800	Nofoalii	79.7	3.92	73.7	3.56	619	22/6/98	
14/8/97	800	Fasito'oouta	67.8	5.21	98.3	3.94	563	22/6/98	logged as Satui originally - smaller clams grow faster
15/8/97	700	Gagaifo	105	3.33	97.9	2.38	155	2/7/98	5 clams transferred to open substrate to monitor growth
18/8/97	500	Satitoa	82.8	6.88	50.2	9.27	69	12/2/98	only two tagged clams remain mean growth taken to Feb 98
18/8/97	610	Mutiatele	86.8	4.15	66.9	3.6	500	14/7/98	389 389
18/8/97	700	Lotopue	95.6	3.92	64	3.34	698	14/7/98	no explanation available for inc stock numbers (stolen?)
19/8/97	700	Malaela	52	4.23	83	3.10	445	14/7/98	362 362
22/8/97	500	Fausaga	85.1	3.52	48.7	6.0	341	16/7/98	
22/8/97	500	Poutasi							Data to be sorted
03/9/97	580	Mulivai	72.3	4.03	108.1	2.91	390	17/7/98	smaller clams growth faster
03/9/97	500	Ulutogia	47.2	3.3	88.6	2.5	248	14/7/98	high density snail area, moved to new place in reserve 750
17/10/97	500	Satapuala	98.8*	4.46			494	22/6/98	second tag tray has inc clams?
20/11/97	500	Sa'anapu					359	3/7/98	
18/2/98	300	Saleaumua	116.8	3.3	77.1	4.85	285	14/7/98	
14/1/98	500	Matafa'a	104.7	1.51	86.9	6.4	57	3/7/98	only surveyed since June98
4/2/98	500	Safa'atoa	88.7*	2.8			43	3/7/98	one tagged tray shows no growth?
21/7/97	1500	Satoalepai							**TBA**
21/7/97	1500	Saleaula							
14/8/97	850	Puapua							
14/8/97	850	Fagamalo							
19/8/97	500	Fagasa							
19/8/97	500	Auala							
21/8/97	500	Asaga							
22/8//97	500	Faala							
26/8/97	500	Asau							
26/8/97	500	Falealupo							
04/11/97	500	Vaito'omuli							
16/9/96	1500	Apai	59.9*	1.87			374	24.1.97	? Clams lost due to rough weather Stock measured at 21/7/98
16/9/96	2000	Salua	92.3*	4.5			34	12/6/98	original tray split some data missing . As of 21/7/98.tag tray missing
16/9/96	2000	Faleuatai	81.6	4.23	73.8	5.23	0	15/12/97	all clams gone - no records after Nov&Dec 97
18/9/96	1500	Lepuia'i	56.2	3.86	70.0	5.02	2	5/11/97	mean taken to July 97 no interim data and almost no stock remaining
18/3/97	1200	Salua'uta	82.1	2.26	112.7	2.54	670	21/7/98	

* mean of one tagged tray available only

To reinforce the need for ownership and good management practise, seventeen village workshops on giant clam maintenance have been conducted during the six-month extension period of the project. The details are summarised in Table 6.

Table 6: Community workshops/demonstrations for Giant clams in the period March to August 1998.

Date	Location/Village	Comments
20 May 98	Asaga (Savaii)	
21 May 98	Vaitu'omili, Asau, Auala (Savaii)	
26 May 98	Puapua (Savaii)	
10 June 98	Poutasi	Formal meeting. Good attendance, including 3 women
16 June 98	Mutiatele, Saleamua, Lotopue	Informal with at least 1 Ctee member in water
18 June 98	Aleipata	Informal with at least 1 Ctee member
22 June 98	Fasito'o tai; Satapuala; Nofoalii	Informal discussion with Pulinuu + Ctee at Fasito;otai; 1 Ctee member at Satapuala 3 members at Nofoalii (in water)
23 June 98	Solosolo; Saluafata	Informal discussion with Ctee during survey of reserve
23 June 98	Saleaula, Fagamalo (Savaii)	
24 June 98	Tauo'o; Moamoa	Informal discussion
24 June 98	Satoalepai, Salelologa (Savaii)	
25 June 98	Faleapuna; Saluafata	Informal discussion with several Ctee members
01 July 98	Gagaifo (Lefaga)	Discussion with Ctee members at formal Extension assessment
13 July 98	Aleipata (5 villages).	Formal meeting. Good attendance, including several women. Some problems with Ulutogia & IUCN
15 July 98	Salelologa (Savaii)	
16-17 July 98	Fusi Safata	Formal meeting. Good attendance
20 July 98	Vailoa	

Since late May, a process of increased dialogue with Village Management Advisory Committees has been initiated, to promote the information acquired from workshops. Fisheries Extension staff provide several days notice of monthly research visits to monitor and measure clams. Then on the day of the visit, both Extension and Research staff work with at least one member of the Committee, out in the reserve. Cage condition is discussed as well as providing on-hands experience of participating in cage cleaning techniques, and identification and removal of predatory snails. In this way ownership and management principles are reinforced and it is hoped that a significant increase in growth rate and decrease in mortality rate will transpire as a result.

During the six-month extension period of the Project, a new pump system, filter and piping were installed to provide seawater to the Fisheries Division's giant clam holding tanks. A large shipment clams, (n=2034), mostly *Tridacna derasa* with a few *T. maxima*, was held in quarantine for FAO from XX July, to 20 July, 1998. Mortality rates were relatively high. Available clams for distribution were reduced to 1620 after three weeks. A large copepod infestation was noted on some animals although water quality and travel stress cannot be overlooked as causal factors for the high mortality.

New introductions - Extension phase (March-August 1998)

Tridacna derasa from original Fisheries Division stock were introduced into an three villages during April, 1998. *Tridacna derasa* from the Fiji stock were distributed to three villages in July, 1998. (One village, Fusi Safata has existing clam aquaculture since 8/8/97). Additionally, stock

obtained from American Samoa in late July, will be available for distribution to a further three villages in early August, 1998, after a quarantine period. These introductions are detailed in Table 7. The total clam aquaculture in Samoa since June, 1996 to the present time is 43 villages .

Table 7 : Introductions of giant clams *(Tridacna derasa)* by date, number and location for the period March to August 1998 inclusive.

Introductions: 1998	**Number**	**Location**	**Current stock**	**Mean growth rate/month**
09/4/98	100	Faleapuna	98	no comparative data available
22/4/98	100	Faleu'uta	113	2.05 and 4.23mm at 21/7/98
12/5/98	120	Saluafata	119	no comparative data available
Current introductions - July				
15/7/98	200	Falealupo (Savaii)	200	Fiji stock appears stressed in holding tanks
17/7/98	1200	Fusi Safata	458 + 1200	Fiji stock
20/7/98	200	Vailoa		Fiji stock
Projected introductions - August				
	200	Faitoa		
	200	Solosolo		
	200	Sapapapali'i		

Comments:

The introduction of the aquaculture of tilapia and giant clams is providing the incentive for villagers to decrease fishing pressure in over-exploited areas, to have less need to resort to damaging fishing methods, and to more readily adopt resource management and conservation practises. As with any new practise there is mixed success. Some villages have more easily moved into the role of ownership and take immense pride in their aquaculture practise. Other villages have yet to assume this ownership role.

The Fisheries Research unit team is also in a transitional period having to acquire more systematic scientific monitoring skills as well as balance extraneous pressures on time in order to adhere to a systematic regime of monitoring the progress of aquaculture. Data recording and analysis will also improve with experience.